

REMARKS

Allowable Subject Matter:

Applicant notes with appreciation the Examiner's indication that Claims 21, 42-47, and 60-62 present allowable subject matter. New Claim 67 is Claim 21 in independent form, and is therefore allowable. New Claim 68 is Claim 42 in independent form, and is therefore allowable. New Claims 69-73 depend from Claim 68, correspond with Claims 43-47, and are therefore allowable. New Claim 74 is Claim 60 in independent form, and is therefore allowable. New Claims 75-76 depend from Claim 74, correspond with Claims 61-62, and are therefore allowable.

Preface:

The above-captioned patent application describes various methods for enhancing the release of a surface micromachined microstructure using embedded, hollow, laterally extending etch release conduits. These etch release conduits extend in the lateral dimension underneath a particular structure to reduce the amount of time that is required to remove a sacrificial material that is disposed under this structure and without requiring etch release holes that extend down through this structure. An introductory example will be provided that emphasizes the significant benefits associated with these types of etch release conduits.

Consider the case where surface micromachining is used to fabricate a microstructure, where a relatively large first structure (in the lateral dimension) is formed, where a sacrificial material is disposed somewhere under this first structure, where this sacrificial material needs to be removed (e.g., to allow the first structure to move), and where there are no etch release that extend down through the first structure to gain access to this sacrificial material for its removal. In order to release the first structure in this case, the release etch must proceed inwardly from a location corresponding

with the perimeter of the first structure in order to remove the underlying sacrificial material. Depending of course on size of the first structure or its "lateral extent", it may take a considerable amount of time to remove the sacrificial material that is located somewhere under the first structure.

One way to reduce the amount of time required to remove the sacrificial material in the above-noted example would be to include a plurality of etch release holes that extend completely through the first structure. In this case the etchant would flow down through the etch release holes to gain more access to the underlying sacrificial material. Although this reduces the time required to remove the underlying sacrificial material, the existence of the etch release holes through the first structure may be detrimental in at least some respect (e.g., may reduce optical performance in the case where the first structure is a mirror or reflective surface).

The etch release conduits described in the specification of the above-captioned patent application provide an alternative to realizing a reduced etch release time and without requiring etch release holes that extend down through the first structure. Generally, the etch release conduits provide a way for a release etchant to reach an "inward" location under the first structure that is faster than merely relying upon the bulk etch rate generally associated with the underlying sacrificial material. That is, the etch release conduits provide a way to "pipe" etchant under the first structure. The release etchant can thereafter proceed "outwardly" from its corresponding etch release conduit (in effect increasing the size of its etch release conduit, and in a direction that is perpendicular to the length dimension of the conduits) at the bulk etch rate.

The various independent claims will now be addressed in relation to the outstanding rejections made by the Examiner in the Office Action.

Independent Claim 1:

Independent Claim 1 is generally directed to a method for making a surface micromachined microstructure. A first sacrificial layer is formed over a first substrate. This first substrate includes an upper surface that extends in the lateral dimension. A plurality of conduits are formed. These
5 conduits are hollow, embedded, have a closed perimeter that is defined at least in part by this first sacrificial layer, and extend in the lateral dimension as well.

A first structural layer is formed over the first sacrificial layer. This first structural layer also extends in the lateral dimension and has a first perimeter that defines the lateral extent of the first structural layer. The plurality of conduits extend in the lateral dimension underneath the first
10 structural layer in a manner such that the first structural layer overlies these plurality of conduits (i.e., if you proceeded vertically upwardly from a given conduit, you would hit the overlying first structural layer). At least one end of at least one of these conduits is at a location in the lateral dimension that at least generally corresponds with a location in the lateral dimension of a corresponding portion of the first perimeter of the first structural layer. In the case where the first
15 structural layer is circular, the above-noted characterization would mean that an end of a conduit is disposed at least generally at the same radial position as a corresponding portion of the perimeter of the first structural layer (e.g., a "vertically aligned" portion). In any case, the first sacrificial layer is removed by flowing an etchant within at least some of the conduits.

Claim 1 stands rejected under 35 U.S.C. §102(b) based upon U.S. Patent No. 5,919,548
20 (hereafter '548 Patent). Applicant respectfully requests reconsideration since the '548 Patent does not disclose the combination of features presented by Claim 1. Generally, the '548 Patent does not disclose forming the type of conduits required by Claim 1 and the use of the same in an etch release. Applicant acknowledges that the '548 Patent refers to the "structure" associated with reference

numeral 52 as "etch release channels." However, these etch release channels 52 do not extend in the lateral dimension somewhere underneath a first structural layer in a manner such that the first structural layer overlies these conduits as required by Claim 1. Moreover, neither of the etch release channels 52 have an end that is at a location in the lateral dimension that at least generally corresponds with a location in the lateral dimension of a corresponding portion of the perimeter of a first structural layer, and then proceeds in the lateral dimension underneath a first structural layer as required by Claim 1.

Based upon the foregoing, Claim 1 is allowable over the '548 Patent. Claims 2-38, which depend from Claim 1, are thereby also allowable over the '548 Patent for the above-noted reasons.

There is therefore no need to separately address the patentability of each of these claims and/or the Examiner's interpretation in relation to any of these claims or any of the references of record in relation thereto.

Independent Claim 39:

Independent Claim 39 is generally directed to a method for making a surface micromachined microstructure. A first sacrificial layer is formed over a first substrate. This first substrate includes an upper surface that extends in a lateral dimension. A first intermediate layer is formed on this first sacrificial layer. A plurality of first strips are thereafter formed from the first intermediate layer and extend in the lateral dimension. Each first strip includes a pair of vertically extending sidewalls.

A second sacrificial layer is formed on the first sacrificial layer and at least alongside each of the noted first strips so as to interface with each sidewall of each first strip (i.e., after the formation of the first strips). A first structural layer is thereafter formed over this second sacrificial layer. The first structural layer extends in the lateral dimension and includes a first perimeter that defines the

lateral extent of the first structural layer. The first strips extend underneath the first structural layer in the lateral dimension such that the first structural layer overlies these first strips. At least one end of at least one of the first strips is at a location in the lateral dimension that at least generally corresponds with a location in the lateral dimension of a corresponding portion of the first perimeter.

5 The first and second sacrificial layers are removed by etching. This etch defines a conduit that extends along each of the vertical sidewalls of each first strip. These conduits are hollow, embedded, have a closed perimeter that is defined at least in part by the second sacrificial material, and extend in the lateral dimension.

Claim 39 stands rejected under 35 U.S.C. §102(b) based upon the '548 Patent. Applicant
10 respectfully requests reconsideration since the '548 Patent does not disclose the combination of features presented by Claim 38. Generally, the '548 Patent does not disclose forming a plurality of conduits by etching sacrificial material alongside a plurality of first strips that extend in a lateral dimension underneath a first structural layer that overlies these first strips. Specifically, the '548 Patent does not disclose a plurality of first strips that extend in the lateral dimension underneath a
15 subsequently formed first structural layer such that the first structural layer overlies these first strips, that have a pair of vertical sidewalls that each interface with a sacrificial layer that is formed after the formation of these first strips, that includes at least one such first strip having an end that is at a location in the lateral dimension that at least generally corresponds with a location in the lateral dimension of a corresponding portion of the perimeter of the first structural layer, where conduits are
20 formed along the pair of vertical sidewalls of these first strips, and where these conduits are hollow, embedded, have a closed perimeter that is defined at least in part by the second sacrificial material, and extend in the lateral dimension.

The Examiner refers to layers 48 and 50 as corresponding with the first strips in Claim 39. A sacrificial layer is not deposited after the formation of either of these layers 48, 50. Sacrificial layers 24 and 40 are both deposited before the deposition of the layers 48, 50 (compare Figure 3e for formation of the first sacrificial layer 24, Figure 3l re formation of second sacrificial layer 40, Figure 3p re formation of patterned metallization 48, and Figure 3q re formation of the protection layer 50).

Based upon the foregoing, Claim 39 is allowable over the '548 Patent. Claims 40-57, which depend from Claim 39, are thereby also allowable over the '548 Patent for the above-noted reasons. There is therefore no need to separately address the patentability of each of these claims and/or the Examiner's interpretation in relation to any of these claims or any of the references of record in relation thereto.

Independent Claim 58:

Claim 58 is generally directed to a method for making a surface micromachined microstructure. A first sacrificial layer is formed over a first substrate. This first substrate includes an upper surface that extends in a lateral dimension. This first sacrificial layer is formed in a manner so as to define a plurality of low density regions within the first sacrificial layer that extend in the lateral dimension. A first structural layer is some time thereafter formed over the first sacrificial layer. This first structural layer extends in the lateral dimension and includes a first perimeter that defines the lateral extent of the first structural layer. The plurality of low density regions each extend in the lateral dimension underneath the first structural layer such that the first structural layer overlies the plurality of low density regions. At least one end of at least one low density region is at a location in the lateral dimension that at least generally corresponds with a location in the lateral dimension of a corresponding portion of the first perimeter of the first structural layer.

The first sacrificial layer is removed by etching. This etching entails etching the plurality of low density regions to define a plurality of conduits using a first etchant. These conduits are hollow, embedded, have a closed perimeter that is defined at least in part by the first sacrificial layer, and extend in the lateral dimension. The conduits extend in the lateral dimension under the first structural layer such that the first structural layer overlies the plurality of conduits. This same first etchant remains in the various conduits to also etch the remainder of first sacrificial layer.

Claim 58 stands rejected under 35 U.S.C. §102(b) based upon the '548 Patent. Applicant respectfully requests reconsideration since the '548 Patent does not disclose the combination of features presented by Claim 58. Generally, the '548 Patent does not disclose forming a plurality of conduits by etching low density regions in a sacrificial material that extend in a lateral dimension underneath a first structural layer that overlies these low density regions. Specifically, the '548 Patent does not disclose forming a first sacrificial layer in a manner that yields a plurality of low density regions that extend in the lateral dimension underneath a subsequently formed first structural layer such that the first structural layer overlies these low density regions, where at least one such low density region has an end that is at a location in the lateral dimension that at least generally corresponds with a location in the lateral dimension of a corresponding portion of the first perimeter of the first structural layer, where a plurality of conduits are formed by etching these low density regions with a first etchant, where these conduits are hollow, embedded, have a closed perimeter that is defined at least in part by the first sacrificial layer, that extend in the lateral dimension (under the first structural layer such that the first structural layer overlies these conduits), and where this first etchant remains in the conduits to etch a remainder of the first sacrificial layer.

The '548 Patent simply discloses etching etch channels 52 down through the structure to gain access the second sacrificial layer 40, and thereafter using a selective etchant to remove the

sacrificial material.

Based upon the foregoing, Claim 58 is allowable over the '548 Patent. Claims 59-62, which depend from Claim 58, are thereby also allowable over the '548 Patent for the above-noted reasons. There is therefore no need to separately address the patentability of each of these claims and/or the Examiner's interpretation in relation to any of these claims or any of the references of record in relation thereto.

Independent Claim 63:

Claim 63 is generally directed to a method for making a surface micromachined microstructure. A first sacrificial layer is formed over a first substrate. This first substrate includes an upper surface that extends in a lateral dimension. A first structural layer is some time thereafter formed over the first sacrificial layer. The first structural layer extends in the lateral dimension and has a first perimeter that defines the lateral extent of the first structural layer. The first sacrificial layer is removed. This removal entails using a first etchant to define at least one etch release conduit that extends in the lateral dimension underneath the first structural layer in a manner such that the first structural layer overlies this etch release conduit(s). This etch release conduit is hollow, embedded, and has a closed perimeter that is defined at least in part by the first sacrificial layer. Thereafter, a second etchant that is different from said first etchant is directed into the noted etch release conduit(s) (that extends underneath the first structural layer in the lateral dimension such that the first structural layer overlies such conduit(s)) to remove the first sacrificial layer.

Claim 63 stands rejected under 35 U.S.C. §103 based upon the '548 Patent and U.S. Patent No. 5,867,302 ('302 Patent). Applicant respectfully requests reconsideration since the '548 Patent and '302 Patent do not suggest the combination of features presented by Claim 63. Neither the '548

Patent nor the '302 Patent disclose using an etchant to define at least one etch release conduit that extends underneath a first structural layer in the lateral dimension in a such a manner that the first structural layer overlies such a conduit, where this conduit is hollow, embedded, and has a closed perimeter that is defined at least in part by the first sacrificial layer, and thereafter directing an etchant into such an etch release conduit to remove the first sacrificial layer. Therefore, no combination of the '548 Patent and the '302 Patent can disclose using a first etchant to define the noted etch release conduit, and then using a different etchant within this conduit to remove the first sacrificial layer.

Based upon the foregoing, Claim 63 is allowable over the '548 Patent and the '302 Patent. Claims 64-66, which depend from Claim 63, are thereby also allowable over the '548 Patent and the '302 Patent for the above-noted reasons. There is therefore no need to separately address the patentability of each of these claims and/or the Examiner's interpretation in relation to any of these claims or any of the references of record in relation thereto.

Supplemental Information Disclosure Statement

Enclosed is a Supplemental Information Disclosure Statement that identifies an issued patent from a patent application that was filed the same day as the above-captioned patent application, and that has a common specification.

Conclusion:

Based upon the foregoing, Applicant believes that all pending claims are in condition for allowance and such disposition is respectfully requested. In the event that a telephone conversation would further prosecution and/or expedite allowance, the Examiner is invited to contact the undersigned.

Respectfully submitted,

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